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Editorial: Coastal wetland protection and restoration: ecosystem processes, functions and services

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Editorial on the Research Topic
Coastal wetland protection and restoration: ecosystem processes, functions and services

Introduction

Coastal wetlands occupy a narrow transitional zone between terrestrial and marine realms, yet they rank among the most productive ecosystems on the planet. Covering less than 0.3% of the global ocean area, they store a disproportionate amount of soil organic carbon (SOC), harbor exceptional biodiversity, and furnish vital ecosystem services such as flood and erosion control, water purification, and nursery habitat. Despite their importance, coastal wetlands are vanishing at alarming rates—approximately 16% of the world's tidal flats were lost between 1984 and 2016 — under the combined pressures of sea-level rise, coastal development, eutrophication, and biological invasions (Murray et al., 2019; Justine and Seenath, 2024; Lovelock et al., 2024; Guild et al., 2024). This lost not only erodes biodiversity but also impairs the buffering functions these ecosystems provide between land and sea. In response, numerous countries have launched restoration initiatives; however, progress is frequently impeded by an incomplete understanding of the mechanisms that underpin successful conservation and restoration. This Research Topic "Coastal Wetland Protection and Restoration: Ecosystem Processes, Functions and Services" was conceived to advance Nature-based Solutions (NbS) to these interlinked challenges (Friess et al., 2024). The five contributions assembled here span from landscape-scale assessments of restoration outcomes to soil biogeochemistry and organism-level responses, collectively strengthening the evidence base for actions that align with the United Nations Sustainable Development Goals (SDGs), particularly SDG 13 (Climate Action), SDG 14 (Life Below Water), and SDG 15 (Life on Land) (Sun et al., 2026).

Restoration outcomes and landscape dynamics

Quantifying the ecological outcomes of restoration interventions is a prerequisite for adaptive management in coastal zones. Yuan et al. evaluated the landscape consequences of a large-scale project in the Liaohe Estuary, China, where mariculture ponds were converted back to tidal flats beginning in 2015. Using high-resolution GF-1 and GF-2 satellite imagery together with landscape metrics, they tracked changes from 2013 to 2023. Pond area declined from 74.84 km^2 to 33. 68 km^2, and 85% of the newly created tidal flats transitioned into *Suaeda salsa* marshes. The landscape stability index improved markedly after an initial period of fluctuation, and the tidal flat mosaic shifted from a fragmented to a more connected configuration, signaling enhanced ecosystem integrity. This case demonstrates that reversing coastal reclamation can restore estuarine wetland landscapes and offers a transferable model for similar initiatives elsewhere (Sun et al., 2026).

Soil carbon enhancement and legacy pollution

Improving degraded soils and safeguarding existing carbon stocks are central to coastal wetland NbS. On the remediation side, Xiaowen et al. explored the potential of biochar derived from two contrasting wetland plants, the invasive *Spartina alterniflora* and the native *Phragmites australis*, to ameliorate salt marsh soils. Across a range of pyrolysis temperatures (350 °C–650 °C) and application rates (1%–3%), both biochars significantly increased soil pH, cation exchange capacity, and nutrient content. The 3% addition rate substantially enhanced nitrogen and phosphorus availability, while both types of biochar increased the proportion of mineral-associated organic carbon, thereby promoting long-term SOC stabilization (Lin et al., 2026). This approach simultaneously addresses invasive species management and soil carbon enhancement, exemplifying how a problematic biomass can be repurposed into a resource.

Conversely, the destruction of existing wetlands can release large amounts of previously stored carbon and pollutants. Goetz et al. reconstructed the environmental history of a salt marsh at Pelham Bay Park's Turtle Cove, New York City, using sediment cores and multi-proxy analyses (XRF, LOI, $\delta^{13}C$, foraminifera, and AMS ^{14}C dating). They documented a ~65% loss of marsh area between 1974 and 2018, coincident with accelerating relative sea-level rise and the expansion of hardened shorelines that restricted tidal exchange. The erosion of peat liberated centuries-old SOC and mobilized substantial quantities of lead into Long Island Sound, revealing the hidden pollution risks that accompany wetland destruction. These findings underscore the importance of preserving intact marshes and incorporating legacy contamination into coastal risk assessments.

Biotic responses to environmental change

Understanding how organisms respond to altered environmental conditions and restoration actions provides sensitive indicators of ecosystem trajectory. Powers et al. investigated the effects of elevated pCO_2 on the intertidal benthic foraminifer *Haynesina* sp., a calcifying protist widespread in temperate salt marshes. Specimens were exposed to moderate (~2386 µatm) and high (~4798 µatm) pCO_2 for 28 days. While moderate acidification had little impact on test thickness, highly elevated pCO_2 induced precipitation deficits and dissolution of the calcareous test, particularly among live individuals. This suggests that the combined stress of coastal acidification and the physiological demands of calcification may exceed the organism's compensatory capacity, potentially diminishing the role of benthic foraminifera as a carbon sink as acidification intensifies (Powers et al.).

On a community level, Gao et al. examined collembolan assemblages in drained and diked salt marshes (DDSM) and adjacent wheat farmlands in Ningbo, southeastern China. Species richness was significantly lower in DDSM habitats than in farmlands, yet community composition was distinct, with several species (*Ceratophysella skarzynskii, Desoria* sp12, *Isotoma pinnata, Sinella* sp.) occurring exclusively in the recovering marshes. Plant coverage and height emerged as the main variables structuring collembolan communities, indicating that vegetation restoration drives the reassembly of soil biodiversity (Gao et al.). The study provides valuable baseline information for conserving invertebrate diversity in reclaimed coastal wetlands.

Conclusion

The studies in this Research Topic collectively illustrate that effective coastal wetland protection and restoration require a multi-faceted perspective that integrates landscape ecology, soil biogeochemistry, and organismal biology. They demonstrate that NbS—whether through large-scale reconversion of aquaculture ponds, biochar-based soil remediation, or vegetation-driven biodiversity recovery—can yield measurable gains in ecosystem structure and functioning. At the same time, the contributions serve as a sobering reminder of the persistent stresses from sea-level rise, acidification, and legacy pollution that can undermine restoration outcomes if not explicitly addressed. Realizing the full potential of coastal wetland NbS will depend on continued innovation in restoration technologies, systematic long-term monitoring, open-access data sharing, and the translation of site-specific knowledge into policy frameworks that adequately value the range of services these ecosystems provide.

Author contributions

J-eL: Supervision, Conceptualization, Writing – review and editing, Writing – original draft. CR: Writing – review and editing, Conceptualization, Methodology. MZ: Formal Analysis, Methodology, Conceptualization, Writing – review and editing. ZL: Data curation, Software, Validation, Writing – review and editing. Cissy Ma: Software, Writing – review and editing, Methodology, Formal Analysis.

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References

Friess, D. A., Shribman, Z. I., Stankovic, M., Iram, N., Baustian, M. M., and Lewis, C. J. E. (2024). Restoring blue carbon ecosystems. *Camb Prism. Coast Futur* 2, e9. doi:10.1017/cft.2024.9

Guild, R., Wang, X., and Quijón, P. A. (2024). Climate change impacts on coastal ecosystems. *IOP Sci.* 3 (4), 042006. doi:10.1088/2752-5295/ad9f90

Justine, Y. E. D., and Seenath, A. (2024). Vegetative nature-based solutions for coastal flood risk management: benefits, challenges, and uncertainties. *Ocean Coast. Manag.* 261, 107520.

Lin, X., Song, G., Luo, X., Lai, J., Zhang, W., Liu, J., et al. (2026). Differential effects of Phragmites australis *versus Spartina alterniflora* biochar on salt marsh soil improvement and carbon stabilization. *Front. Environ. Sci.* 14, 1759974.

Lovelock, C. E., Bennion, V., de Oliveira, M., Hagger, V., Hill, J. W., Kwan, V., et al. (2024). Mangrove ecology guiding the use of mangroves as nature-based solutions. *J. Ecol.* 112 (8), 1678–1692. doi:10.1111/1365-2745.14383

Murray, N. J., Phinn, S. R., DeWitt, M., Ferrari, R., Johnston, R., Lyons, M. B., et al. (2019). The global distribution and trajectory of tidal flats. *Nature* 565, 222–225. doi:10.1038/s41586-018-0805-8

Sun, H., Wang, M., Wang, G., Zhang, T., Meng, J., and Yang, Q. (2026). Effects of tidal Creek order on *Suaeda salsa* growth in the liaohe Estuary wetland: mechanisms and implications for restoration. *Ecosyst. Health Sustain.* 12, 0464. doi:10.34133/ehs.0464